Experiment 1: Parametric Curves

CZ2003 Computer Graphics and Visualization

SS3

Name	Matric Number
Pang Yu Shao	U1721680D

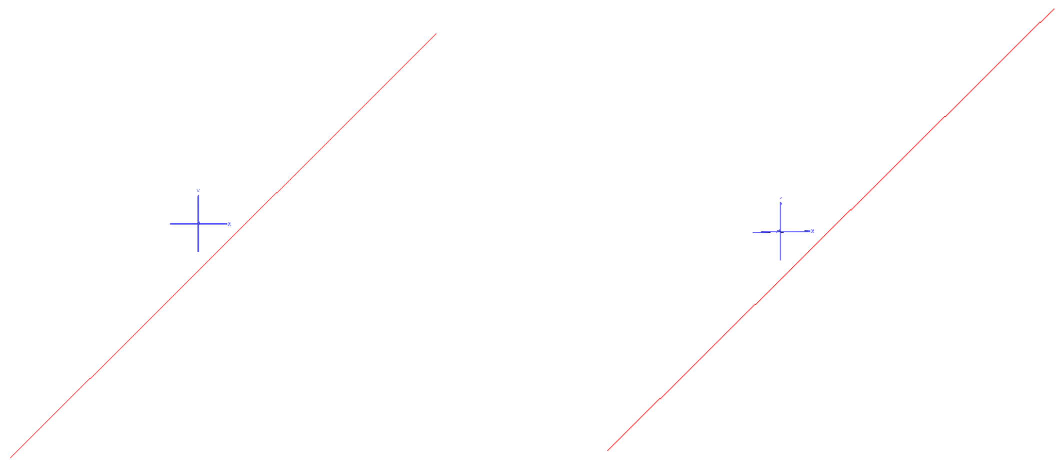
SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

2nd Febraury 2021

Contents

1 DEFINING SHAPES PARAMETRICALLY

1.1 Straight Line Segment



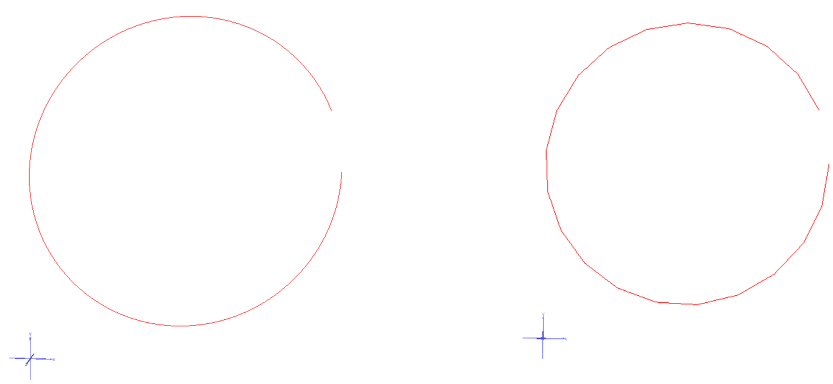
(a) Resolution: 1

(b) Resolution: 100

Fig. 1. Plots of the straight line segment defined in "**1a.wrl**" with differing resolutions

As seen in Fig. 1 above, a sampling resolution of **1** is sufficient for drawing a straight line segement.

1.2 Circular Arc



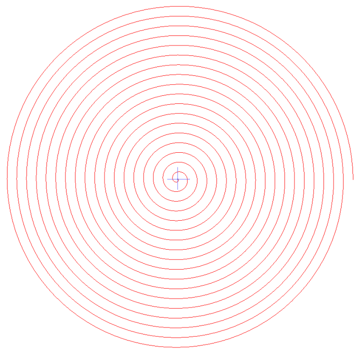
(a) Resolution: 120

(b) Resolution: 20

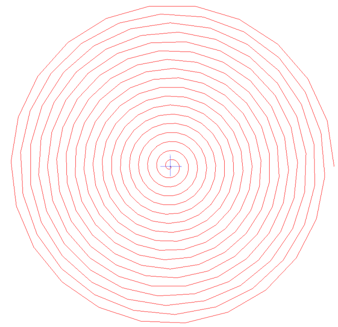
Fig. 2. Plots of the circular arc segment defined in "**1b.wrl**" with differing resolutions

As seen in Fig. 2 above, a higher sampling resolution of **120** is required for drawing the circular arc in order for it to appear as a smooth arc. When the sampling resolution is reduced to 20, the polyline interpolation of the curve is revealed.

1.3 2D Spiral Curve



(a) Resolution: 1800



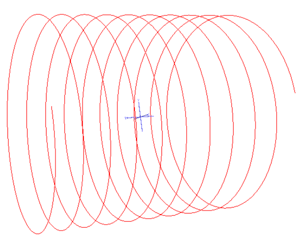
(b) Resolution: 400

Fig. 3. Plots of the spiral curve defined in "**1c.wrl**" with differing resolutions

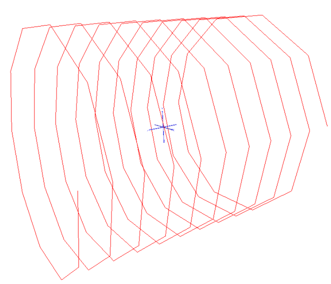
As seen in Fig. 3 above, a much higher sampling resolution of **1800** is required for drawing the spiral curve in order for it to appear smooth. This is due to the fact that the spiral has a large number of spirals (18), and therefore the sampling locations on the outer part of the spiral are further apart as compared to the inner part of the spiral.

This can be seen when the sampling resolution is reduced to 400 in Fig 3b, the inner parts of the spiral appears smooth, while the polyline interpolations can be seen on the outer parts of the spiral

1.4 3D Cylindrical Helix



(a) Resolution: 800



(b) Resolution: 100

Fig. 4. Plots of the cylindrical helix defined in "**1d.wrl**" with differing resolutions

As seen in Fig. 4 above, a much higher sampling resolution of **800** is required for drawing the cylindrical helix in order for it to appear smooth. When the sampling resolution is reduced to 100, the polyline interpolation of the curve is revealed.

2 CONVERTING EXPLICITLY DEFINED CURVE TO PARAMETRIC REPRESENTATIONS

For this task, an explicitly defined curve has to be converted to its Parametric Representations. The following explicitly defined curve was assigned:

$$y = tanh\ x$$

$$x \in [-1.3N, 2N], where\ N = 8$$

Therefore, the follow parametric functions can be obtained:

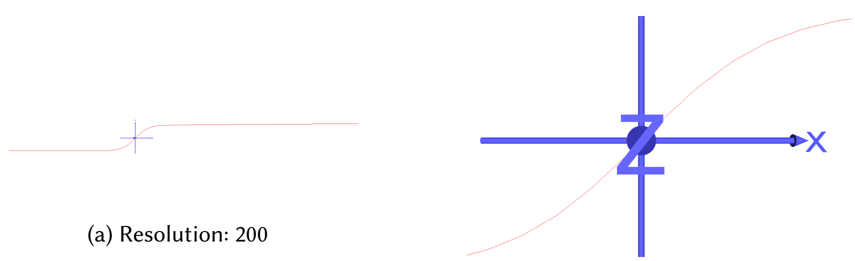
$$x(u) = (-1.3 * 8) + u * ((2 + 1.3) * 8)$$

$$\mathbf{x(u) = -10.4 + 26.4 * u}$$

$$\mathbf{y(u) = tanh(-10.4 + 26.4 * u)}$$

$$u \in [0, 1]$$

By plotting the parametric equations defined above, we get the following display:



(a) Resolution: 200

(b) Resolution: 100

Fig. 5. Plots of the parametrically defined curve in "**2d.wrl**" with differing resolutions

When the resolution is 200, a smoother curve is obtained. With a lower sampling resolution like 100, when the figure is zoomed in, the sharp edges of where the polyline interpolations meet is visible.

3 CONVERTING CURVE DEFINED IN POLAR COORDINATES TO PARAMETRIC REPRESENTATIONS

For this task, a curve defined using polar coordinates has to be converted to its Parametric Representations. The curve is defined by:

$$r = N - (M+5)cos\alpha \quad \alpha \in [0, 2\pi],\ N = 8,\ M = 10$$
$$r = 8 - (10+5)cos(\alpha)$$
$$r = 8 - (15)cos(\alpha)$$

We can convert between polar to cartesian with the following formulas:

$$x = rcos(\alpha)$$
$$y = rsin(\alpha)$$

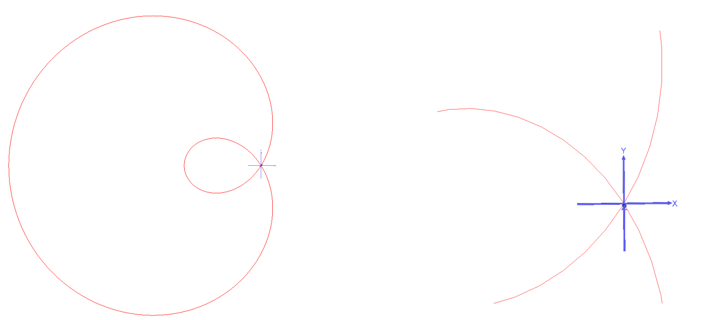
Therefore, we can get:

$$x(\alpha) = (8 - 15cos(\alpha))cos(\alpha)$$
$$y(\alpha) = (8 - 15cos(\alpha))sin(\alpha)$$
$$\alpha \in [0, 2\pi]$$

Converting domain from α to u:

$$\mathbf{x(u) = (8 - 15cos(2\pi u))cos(2\pi u)}$$
$$\mathbf{y(u) = (8 - 15cos(2\pi u))sin(2\pi u)}$$
$$u \in [0, 1]$$

By plotting the parametric equations defined above, we get the following display:



(a) Resolution: 200

(b) Resolution: 100

Fig. 6. Plots of the parametrically defined curve in "**3.wrl**" with differing resolutions

Similar to the figures obtained in Fig 5, when the resolution is 200, a smoother curve is obtained. With a lower sampling resolution like 100, when the figure is zoomed in, the sharp edges of where the polyline interpolations meet is visible.